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Published in:
Marine Policy

Link to article, DOI:
10.1016/j.marpol.2016.11.028

Publication date:
2017

Document Version
Publisher's PDF, also known as Version of record

Marine Policy 76 (2017) 98–106

Contents lists available at ScienceDirect

Marine Policy

journal homepage: www.elsevier.com/locate/marpol

Remote electronic monitoring and the landing obligation – some insights into fishers' and fishery inspectors' opinions

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ARTICLE INFO

Keywords:
Fisheries management
Discard ban
Compliance
Fully Documented Fisheries
Fishery inspectors
Interviews

ABSTRACT

The European fisheries management is currently undergoing a fundamental change in the handling of catches of commercial fisheries with the implementation of the 2013 Common Fisheries Policy. One of the main objectives of the policy is to end the practice of discarding in the EU by 2019. However, for such changes to be successful, it is vital to ensure stakeholders acceptance, and it is prudent to consider possible means to verify compliance with the new regulation. Remote Electronic Monitoring (REM) with Closed-Circuit Television (CCTV) has been tested in a variety of fisheries worldwide for different purposes and is currently considered as one possible tool to ensure compliance with a European ban on discards.

This study focuses on Danish fishery inspectors and on fishers with REM experience, whose opinions are less well known. Their views on the landing obligation and on the use of REM were investigated using interviews and questionnaires, and contrasted to some fishers without REM experience. 80% of fishery inspectors and 58% of REM-experienced fishers expressed positive views on REM. 9 out of 10 interviewed fishers without REM experience were against REM. Participation in a REM trial has not led to antipathy towards REM. Fishery inspectors saw on-board observers, at-sea control and REM as the three best solutions to control the landing obligation but shared the general belief that the landing obligation cannot be enforced properly and will be difficult for fishers to comply with. The strengths and weaknesses of REM in this context are discussed.

1. Introduction

The pressure for a change in fishing practices in the European Union (EU) increased throughout the 2000s, not least due to public demand like the *Fish Fight* campaign that demanded the end of discarding in the EU [1–4]. Discards are the part of the catch that is returned to the sea [5]. The public and environmental NGOs perceive discarding as unsustainable, unethical and a waste of resources, which has led to attempts to limit or end the practice [4,6–9]. Measures for this include increased gear selectivity, effort restrictions, quota limitations, temporal and spatial restrictions, transferability of quotas and discard bans [3,10,11]. Discard bans have been in place in Iceland since 1977, in Norway since 1983 and at the Faroe Islands since 1994 [11,12]. With the entry into force of the landing obligation of the 2013 Common Fisheries Policy (CFP) a discard ban is now also being implemented in the EU [13]. Banning discards is meant to ensure that total catches do not exceed the threshold defined by the regulatory framework (e.g. Maximum Sustainable Yield, MSY). Compliance with the landing obligation therefore requires a Catch Quota Management scheme (CQM) that aims at managing both wanted and unwanted catches. Documentation of all catches is thus required to verify CQM, a concept referred to as Fully Documented Fisheries (FDF) [4,14,15]. Measures to conduct FDF include self-sampling, reference fleets, on-board observers and Remote Electronic Monitoring (REM) with Closed-Circuit Television (CCTV) [16]. The use of REM with CCTV, henceforth referred to as REM in this paper, as a tool to obtain FDF has been tested in a number of countries, including Canada, the US, Australia, New Zealand, Denmark, the UK, the Netherlands and Germany [14,15,17–31]. Ongoing technological developments are taking place to increase the reliability, the cost-efficiency and the scientific added-value of the data collected by REM [23,32]. The primary reservation against REM has however not been on data validity but on the ethical dilemma as to whether the surveillance level imposed by such a measure is acceptable [3,16,33]. A study among UK

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http://dx.doi.org/10.1016/j.marpol.2016.11.028
Received 20 September 2016; Received in revised form 16 November 2016; Accepted 16 November 2016

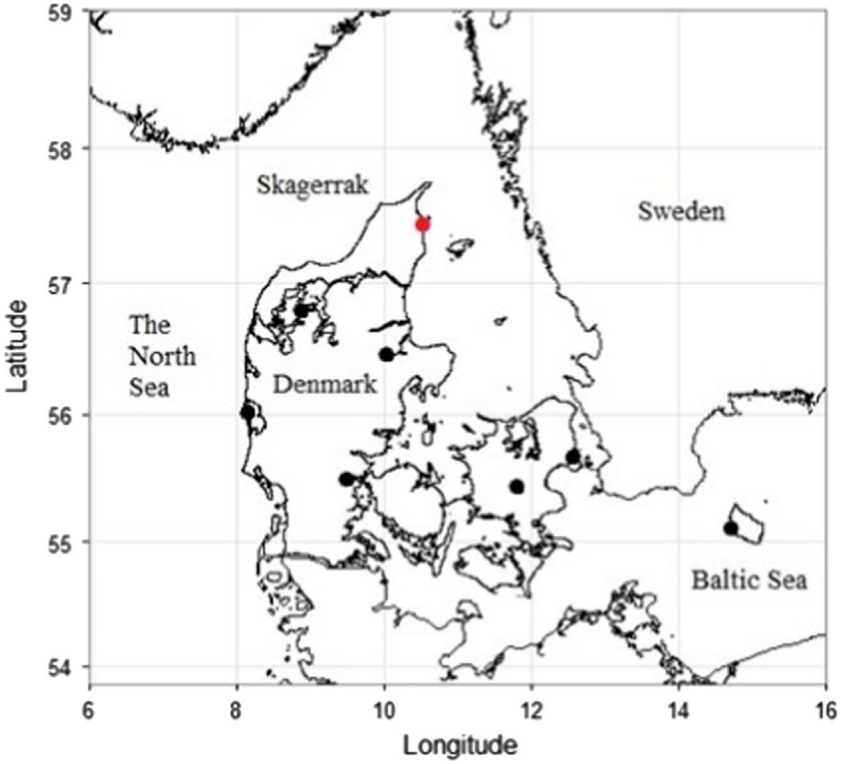

Fig. 1. Permanently manned fisheries control departments in Denmark. Black dots represent departments from where responses to the questionnaire were obtained, seven in total. Red dots represent departments where no responses to the questionnaire were obtained, one in total.

fishers showed that REM was seen as an intrusion and that fishers had concerns on whether video footage could be used to discredit the fisheries [16]. The authors also investigated which incentives could mitigate the perceived nuisance and encourage participation in FDF, with direct payment and additional quota scoring highest [16]. Much less known are the views among another primary group of REM users, the fishery inspectors in charge of enforcing the regulations imposed on the fisheries. The nature of their work and their day-to-day interactions with fishers provide fishery inspectors with experience and detailed understanding of regulations and of practical issues in the fisheries, but little attempt has been made so far to collect their knowledge and integrate it into the design of the fishery policy. Accordingly, this study investigates the opinions of Danish fishery inspectors' on the use of REM as a measure for control, monitoring and surveillance (MCS) and on their expectations for the landing obligation, in order to assess whether coercive measures are likely to be needed to ensure compliance with the landing obligation. A similar investigation among some Danish fishers is also conducted, including both fishers with and without REM experience, in order to contrast the results. The main driver for fishers is to ensure profits through the harvest of fish stocks whereas fishery inspectors' main objective is to enforce fishery regulations: Hence, it is expected that the perception on the meaningfulness and the viability of different regulations as well as on the practical obstacles imposed by these regulations may vary between these two groups of stakeholders. This article therefore aims at highlighting specific areas of convergence or divergence of perceptions between fishery inspectors and fishers.

2. Material and methods

2.1. Questionnaires for fishery inspectors

The Danish fisheries control is organised as part of the Danish AgriFish Agency under the Ministry of Environment and Food of Denmark. The fisheries control is organised with the central office placed in the capital, seven departments with a permanent staff and three control vessels [34,35]. The collaborators at the Danish fisheries control stated that they preferred a questionnaire to semi-structured interviews and believed that a higher proportion of responses would be obtained if the fishery inspectors received and responded to the questionnaire by email rather than if they were contacted in person or by telephone. A questionnaire covering 16 questions and intended to take approximately 10 min to complete was therefore developed. The majority of the questions were open-ended questions, except for questions relating to the ranking of MCS measures and positive/negative effects on the marine environment and fisheries, which were close-ended, though with possibility for a follow-up explanation. Prior to distribution, the questionnaire was tested and revised with a Senior Fisheries Officer from the Danish AgriFish Agency experienced with the use of REM in the fisheries control. A Chief Officer distributed the questionnaire by email to all sections in the Danish fisheries control. The Danish fisheries control head office in Copenhagen did not actively encourage fishery inspectors to respond to the questionnaire but knew of it and permitted the survey. Respondents returned the filled questionnaire by email to the Chief Officer who collected and forwarded the questionnaires. Respondents were thereby anonymous to the author of this article but not to the Chief Officer. On two occasions, the Chief Officer sent reminders to departments from where no responses had been received after three months. In total, these reminders led to four additional respondents. Based on the diverse answers from the respondents (see Section 2.2) this central collection is not expected to have influenced the answers from the respondents.

2.2. Fishery inspectors' representation

The total number of relevant fishery inspectors in Denmark was 95 at the time of writing. 30 fishery inspectors filled in and returned the questionnaire, corresponding to 31.6% of Danish fishery inspectors. Respondents came from the central office in Copenhagen, from six out of seven regional departments and from two out of three control vessels

Table 1
Diversity in geography and job title among responding fishery inspectors depending on REM-experience.

	REM-experienced fishery inspectors, n=21	Non-REM-experienced fishery inspectors, n=9
Department	Control vessel "Vestkysten" (n=6) Control vessel "Havørnen" (n=1) Fredericia (n=4) Nykøbing Mors (n=4) Hvide Sande (n=2) Rønne (n= 1) Copenhagen (n=1) Department not specified (n=2)	Control vessel "Vestkysten" (n=2) Control vessel "Havørnen" (n=1) Fredericia (n=1) Ringsted (n=1) Hvide Sande (n=1) Randers (n=1) Control vessel, unspecified (n=1) Department not specified (n=1)
Title	Fishery inspector (n=10) Vice fishery inspector (n=1) Senior fisheries officer (n=1) Master mariner (n= 3) Chief Officer (n=3) First mate (n=2) Title not specified (n=1)	Fishery inspector (n=3) Senior fisheries officer (n=1) Master mariner (n= 2) First mate (n=2) Title not specified (n=1)
Type of REM experience	At-sea control on a vessel with REM (n=9) Changed REM hard drives on vessels (n=8) Reviewed video footage (n=3) Drafted terms for REM trials (n=1)	None (n=9)

(Fig. 1).

Out of the 30 respondents, 21 had experience with REM (Table 1). Of these 21, nine had encountered REM while undertaking an inspection of a vessel, implying that these fishery inspectors have seen but not engaged in the use of a REM system. Eight of the 21 had changed hard drives on vessels participating in a trial using REM. Three of the 21 had viewed some of the video footage recorded by a REM system. One of the 21 had participated in the drafting and implementation of regulations in connection with the usage of REM. Various trials on REM have been conducted in Denmark since 2008 [14,15,28,29] and some were still in operation at the time of writing. There has thus been ample time for fishery inspectors to encounter a vessel with REM. It is therefore not seen as a bias that 70% of responding fishery inspectors has encountered REM in some way.

2.3. Interviews with fishers

A total of 22 interviews with fishers were conducted between 7 September and 9 November 2015 based on questions similar to those in the questionnaire distributed to the fishery inspectors but including questions related to practical fishing issues and to specific experiences with REM trials when relevant. Questions related to opinions on the effects of the landing obligation and REM was the same for fishers as for fishery inspectors. Of the 22 interviews, 14 were conducted at the 24th International Fisheries Exhibition, *DanFish,* in Aalborg, Denmark from 7 to 9 September 2015. During the exhibition, 43 fishers were approached with 14 willing to be interviewed. This exhibition was chosen as the main place for interviewing fishers because it provided an opportunity to contact a large number of fishers within a short time frame. Additionally, it was expected that fishers attending the exhibition would be more likely to take the time to be interviewed without prior arrangements because they would not be influenced by external factors like good or bad fishing weather. However, collecting interview data at the *DanFish* exhibition limited the sampling frame to fishers who were attending the exhibition, including only a small number of fishers with REM experience. Therefore, eight additional interviews were conducted by telephone from 14 October to 9 November 2015. Fishers interviewed by telephone had given their contact information and declared their willingness to participate in a telephone interview during a local meeting on the use of REM held on 18 August 2015. Present at the meeting were representatives from the Danish AgriFish Agency, DTU Aqua, the Danish Fishermen's Association and local fishers – mainly skippers - in Hanstholm, Denmark. This prearranged possibility for future interviews allowed for an extension of the data gathered from fishers' interviews, including more responses from REM-experienced fishers. Incidentally, it cannot be excluded that there is a bias in the data arising from differences between face-to-face and telephone interviews, even though the questions were the same. Interview time ranged between 30 and 45 min for both interviews conducted face-to-face or by telephone. Difference in length of interviews mainly depended on the number and length of explanations made by fishers to clarify their responses.

2.4. Fishers' representation

A total of 22 fishers were interviewed. Of these, 12 had experience with REM by being participants in Danish REM trials, and 10 had no experience with REM (Table 2).

By coincidence, the fishers without REM experience interviewed at the exhibition represented a more diverse part of the Danish fishing industry in terms of gear type, target species and area than the interviewed REM-experienced fishers, who were all operating demersal trawlers in the North Sea and Skagerrak. The largest and longest running Danish trial on REM is the Cod Catch Quota Management trial which started in 2010 [14,15]. Although some Danish seiners and gillnetters have participated in this trial, the majority of vessels have been trawlers [14]. The incentives to participate in this trial – a 30% increase in cod quota - has been criticised for potentially selecting for demersal trawlers with substantial cod quota [36], emphasising the importance of keeping in mind that other REM-experienced fishers using other gear types like gillnet, longline, pelagic trawl or seine may have different views than those expressed here. In all, interviewed REM-experienced fishers represented 29.0% of all Danish vessels participating in all REM trials and 50.0% of Danish REM trawlers.

2.5. Data handling

Responses from fishery inspectors were compiled manually after

Table 2
Gear type, fishing area, job title and target species of interviewed fishers.

	REM-experienced fishers, n=12	Non-REM-experienced fishers, n=10
Gear types	Trawl (n=12)	Danish seiner (n=1) Trawl (n=3) Industrial trawl (n=2) Gillnet (n=4)
Main fishing area	The North Sea (n=12)	Skagerrak (n=5) The North Sea (n=3) Kattegat (n=2)
Main target species	Mixed demersal, mainly *Nephrops*, plaice, cod, saithe, haddock and hake (n=12)	Plaice and cod (n=1) Cod, haddock, whiting and saithe (n=1) Sprat and sandeel (n=2) *Nephrops* (n=2) Cod, plaice, sole, hake and saithe (n=4)
Title	Skipper (n=9) Crew (n=3)	Skipper (n=6) Crew (n=4)

collection. Responses to close-ended questions were easily compiled whereas responses to open-ended questions had to be categorised in order to compare responses. Response categories were developed and fitted empirically in order to highlight the main points while avoiding removing important nuances. Although great care has been given to this process, it cannot be fully ruled out that the inherent interpretation taking place in such a categorising may reduce the scope of the collected data.

Responses from fishers were also categorised manually but as fishers' responses came during a live conversation, the interviewer's interpretation and categorisation of the responses were read to the fisher who could then acknowledge or reject and elaborate on the response. This check on responses was done during the interview to avoid misunderstandings.

As the respondents from both the fishery inspectors' group and the REM-experienced fishers' group represented at least 30% of their group, their responses were considered sufficiently representative to be treated quantitatively. The ten fishers without REM experience are a heterogeneous group and represent less than 0.5‰ of the approximately 4800 registered fishers in Denmark [37]. As such, their responses cannot be considered representative for all fishers in Denmark without REM experience but are included to extend and contrast views.

3. Results

3.1. Fishery inspectors' views on REM

In all, 80% of the interviewed fishery inspectors could say something positive about REM (Table 3), primarily pointing out its potential for full documentation and compliance with discard regulations (63%). However, 20% of fishery inspectors did not see any benefits in REM. Concerns on the use of REM revolved around the possibility to bypass the cameras, because REM is presented as a tool for full documentation, which almost 23% of the fishery inspectors did not believe REM will allow for. Additionally, the surveillance level was seen as an intrusion by 27% of the fishery inspectors.

Table 3
The positive, negative and overall opinion on REM, fishery inspectors.

		Fishery inspectors (n=30)	
Questions	Answers	N	%
Can you say something positive on REM with CCTV? (open ended question)	Should allow for full documentation	10	33.3
	Should ensure compliance with discard regulations	9	30.0
	No	6	20.0
	Has a preventive effect	3	10.0
	Can be expanded to form a reference fleet	1	3.3
	Relatively cheap control measure	1	3.3
Can you say something negative on REM with CCTV? (open ended question)	Can be bypassed for instance due to blind spots	8	26.7
	The surveillance level is an intrusion.	8	26.7
	It is not full documentation but people think it is	7	23.3
	Insufficient as the sole control measure	3	10.0
	Expensive	2	6.7
	Vulnerable to smudge or water droplets on the camera lenses	2	6.7
Are you generally for or against the use of REM with CCTV?	For	12	40.0
	Against	5	16.7
	Neither for nor against	13	43.3

Table 4
Average and median ranking for seven MCS measures, n=26.

MCS measure	Average rank	Median rank	Lowest rank	Highest rank[a]
On-board observer	2.1	1	7	1
At-sea control	2.3	3	4	1
REM with CCTV	3.2	3	6	1
Reference fleet	4.1	4	7	1
Control of landings	4.7	4	7	2
Logbook	5.4	5	7	3
Genetic control	5.8	6	7	2

The highest possible rank was 1, lowest possible rank was 7. Six of the 26 respondents were unfamiliar with genetic control. Two of the 26 respondents were unfamiliar with reference fleets as a MCS measure. All 26 respondents gave a score for on-board observers, at-sea control, REM, control of landings and logbooks.

[a] Lowest and highest rank refer to the lowest and highest rank given by any respondent.

In general, 17% of the fishery inspectors were against REM but with 40% of fishery inspectors being for the use of REM and 43% being undecided, the majority of fishery inspectors did not oppose REM as a MCS measure.

The fishery inspectors then ranked seven MCS measures (Table 4). Fishery inspectors could add other MCS measures in a subsequent open-ended question but the respondents proposed no other measures. Four of the 30 respondents completed the ranking in a wrong manner by giving the same score to several MCS measures or leaving blank cells. The scoring from these four respondents was excluded.

3.2. Fishery inspectors view on the landing obligation

More than 80% of the 30 fishery inspectors stated that enforcing the landing obligation was the main challenge as they did not see how it would be possible to control and thereby enforce the landing obligation (Table 5).

Most fishery inspectors were unsure whether the landing obligation would have a positive effect on the marine environment, but did not believe either that it may have a negative impact (Table 6).

The potential positive reasons given were the reduction in fishing mortality and the increase in selectivity if discarding ends. The negative reasons were non-compliance with the regulation or that the end of discarding would lead to a loss of available food sources among marine organisms which in turn may lead to a lower production. Additionally, fishery inspectors were asked on the positive and the negative effects of the landing obligation on the Danish fisheries (Table 7).

The potential positive reasons were a better public image and increased quota when discards were no longer included in the stock assessments.

The negative reasons were the increased complexity in regulations and the inherent mismatch between a continuation of the current quota system and a discard ban where choke species, increased handling time and shortage of storage space were mentioned as issues.

Table 5
Challenges for the fishery control with the landing obligation.

		Fishery inspectors (n=30)	
Question	Answers	N	%
What do you see as the primary challenge regarding the landing obligation, for the fisheries control? (open ended question)	Enforcing the landing obligation	25	83.3
	Getting the fishers to see why the landing obligation is meaningful	3	10.0
	No new challenges	1	3.3
	Did not answer	1	3.3

Table 6
Effect of the landing obligation on the marine environment.

Questions	Answers	Fishery inspectors (n=30) N	%
Do you believe that the landing obligation will have a *positive* effect on the marine environment?	Yes	10	33.3
	No	7	23.3
	Do not know	13	43.3
Do you believe that the landing obligation will have a *negative* effect on the marine environment?	Yes	1	3.3
	No	19	63.3
	Do not know	10	33.3

Table 7
Effect of the landing obligation on the Danish fisheries.

Questions	Answers	Fishery inspectors (n=30) N	%
Do you believe that the landing obligation will have a *positive* effect on the Danish fisheries?	Yes	13	43.3
	No	11	36.7
	Do not know	6	20.0
Do you believe that the landing obligation will have a *negative* effect on the Danish fisheries?	Yes	9	30.0
	No	13	43.3
	Do not know	8	26.7

3.3. Fishers' opinion on REM

Fishers' were asked the same questions on REM as fishery inspectors (Table 8).

All interviewed fishers who had participated in a REM trial could state something positive about the concept, mainly pointing to quota uplift, public goodwill and more sustainable fisheries. This is in contrast to the interviewed fishers without REM experience where the majority did not have anything positive to say regarding REM. As one non-REM experienced fisher responded: "*No. It is a waste of time and gives no results for the stocks*".

The issues with REM most frequently mentioned by REM-experienced fishers were the constant surveillance first, and as second the fact that all European vessels should carry REM. The current use of REM does not match well with "*an equal playing field*" if not all EU vessels have a REM system installed. The surveillance level was also the main issue raised by non-REM-experienced fishers but even though the issue was the same, non-REM-experienced fishers expressed their disapproval in stronger wordings than REM-experienced fishers, with a tendency to emphasise that they perceived REM as a criminalisation of the fishing industry. As one non-REM-experienced fisher put it: "*It is idiotic! Are fishers criminals? ".*

Non-REM-experienced fishers also criticised REM for being a waste of time that can be misused to discredit the industry and a few stated that the trials are skewed and therefore cannot be used for anything. Specific criticisms of the trial setups were also pointed out as issues among REM-experienced fishers, such as an inadequate feedback on trial results. One REM-experienced fisher came with possibly the one response that best illustrate that some REM-experienced fishers do not perceive major issues with REM, simply responding in a humoristic manner that the main negative aspect of REM was that they could no longer high-grade.

Except for one who was undecided, all interviewed non-REM-experienced fishers were against the use of REM, whereas the majority of interviewed REM-experienced fishers were for the use of REM. However, some sort of reward should accompany the REM system (Table 9). As a REM-experienced fisher put it: "*If it was up to me everyone should have REM on-board. But we want something for having cameras on-board.*"

Table 8
The positive, negative and overall opinion on REM, fishers' responses.

Questions	Answers	REM-experienced fishers (n=12) N	%	Non-REM-experienced fishers (n=10) N	%
Can you say something positive about REM with CCTV? (open ended question)	Quota increase	5	41.7	1	10.0
	No/Nothing	0	0.0	6	60.0
	Increase in public goodwill/image improvement	3	25.0	0	0.0
	Induce adaptions for more sustainable fisheries	3	25.0	0	0.0
	REM can catch those who cheat	0	0.0	3	30.0
	Better stock assessment	1	8.3	0	0.0
Can you say something negative about REM with CCTV? (open ended question)	Surveillance is a criminalisation of the industry	0	0.0	4	40.0
	Constant surveillance	4	33.3	0	0.0
	Nothing particular but should apply to all European vessels	3	25.0	0	0.0
	REM trials are skewed since extra cod quota changes the target species for participants	0	0.0	2	20.0
	REM is waste of time with no actual effect	0	0.0	2	20.0
	Video footage can be misused	0	0.0	1	10.0
	Inadequate feedback from REM project	1	8.3	0	0.0
	Too expensive since extra quota have been necessary to be bought due to regulations on CQM	1	8.3	0	0.0
	Result of micromanagement which is harsh for the fishing industry compared to the agricultural sector	1	8.3	0	0.0
	Vessels participating in REM trials have become dependent on the extra quota	1	8.3	0	0.0
	We can't high-grade	1	8.3	0	0.0
	No	0	0.0	1	10.0
Are you generally for or against the use of REM with CCTV?	For	7	58.3	0	0.0
	Against	4	33.3	9	90.0
	Undecided	1	8.3	1	10.0

Quota uplifts were clearly favoured as a compensation for REM, although the possibility to store bycatch as ensilage and less technical rules (free gear choice) were mentioned as well by REM-experienced fishers. In contrast, no non-REM-experienced fishers would take REM on if free selection of gear was the only reward. Although some non-REM-experienced fishers were willing to take on REM if this was accompanied by a quota uplift, other non-REM-experienced fishers were quite passionate in stating that no reward could ever mitigate the nuisance of having REM on-board. Quoting one of these respondents: "*The question is not relevant. A quota increase cannot be great enough for me to be willing to sell my soul*".

3.4. Fishers' opinion on the landing obligation

Interviewed fishers were generally quite negative in their opinion

Table 9
Fishers' willingness to take on REM depending on the accompanying benefit.

		REM-experienced fishers (n=12)		Non-REM-experienced fishers (n=10)	
Questions	Answers	N	%	N	%
If REM gave the right to free selection of fishing gears, would you then take cameras on board?	Yes	2	16.7	0	0.0
	No	8	66.7	10	100.0
	Did not answer	2	16.7	0	0.0
If REM gave an increase in quota, how large would such an increase have to be for you to take cameras on board?	20%	2	16.7	0	0.0
	30%	7	58.3	4	40.0
	100%	0	0.0	1	10.0
	No quota increase could be large enough	1	8.3	4	40.0
	Did not answer	2	16.7	1	10.0

on the landing obligation. Fishers did not only fear the economic profitability of their sector after the introduction of the landing obligation; they were also largely confused and felt harassed stating that they expected an increase in bureaucracy with incoherent regulations as a result. As one non-REM-experienced fisher stated: "*We don't know what is going on. There is no description. We are not allowed to land it (the catch, red.) and we are not allowed to discard. What do they want us to do with it?*".

Some of the responding REM-experienced fishers were less worried of the impact of the regulation, with one respondent stating to a question on whether they had done or would make any specific preparation prior to the implementation of the landing obligation for their fishery: "*No. We have nothing to hide and can handle it*".

However, the majority of interviewed fishers, regardless of gear or experience with REM, believed that the landing obligation would have a negative effect on the Danish fisheries due to issues with choke species, storage space, handling time, quota settings and marketing. All these issues were believed to hamper the economic sustainability of the fisheries. Additionally, hardly any interviewed fisher (1 out of 22) believed the landing obligation would have a positive effect on the marine environment. Indeed, the majority of interviewed fishers believed that rather than improving the status of the marine environment, the landing obligation would be damaging to the marine environment (15 out of 22). Reasons given for this were the increased mortality for fish that would have survived discarding (but will be taken ashore with the landing obligation) and the decrease in available food sources for organisms that feed on discards, be it seabirds, other fish or benthic organisms. A few other responding fishers (6 out 22) did not see the landing obligation as having neither a negative nor a positive effect. These respondents see the landing obligation as indifferent. Quoting one of these respondents, an industrial trawl fisher who had already been operating under the landing obligation for almost one year: "*It (the landing obligation red.) is just another type of documentation. The fishing practice is not changed as such.*"

4. Discussion

4.1. Opinions on REM

The practical knowledge on REM was not homogenous among responding fishery inspectors as almost one third had no REM experience and another third had only encountered REM while performing at-sea control on a REM vessel. Only four out of the 30 responding fishery inspectors had actually reviewed video footage from REM systems. This does not mean that the take on REM is unimportant for the majority of fishery inspectors but it should be kept in mind that most of the fishery inspectors have little if any practical experience with REM and therefore may have been influenced in their beliefs from talks on REM with co-workers or fishers.

Among fishery inspectors, the possibility to cheat REM by bypassing the CCTV field of view was widely seen as a downside with this system, not least on the basis that REM is presented as being a reliable tool for achieving full documentation. The other major issue perceived with the use of REM is the intrusiveness of cameras. The risk of smudge sticking to camera lenses and the cost of operating a fisheries monitored by REM were also raised as issues, although, other fishery inspectors pointed to the opposite opinions arguing for the lower cost and better level of control as the possible gains from REM. This suggests either quite divergent perceptions of the outcomes of the Danish trials on REM among fishery inspectors in Denmark or that the questionnaire setup has increased the divergence on the subject. Because the opinion on REM was investigated both with a question on the positive and a question on the negative aspects of REM in the questionnaire, this could have led to positive and negative responses on REM from respondents who may have only stated a positive or negative aspect if responding to a single open-ended question on their general opinion on REM.

Globally, fishery inspectors viewed at-sea control and on-board observers as superior MCS tools compared to REM, but only at-sea control had a low spread in the scoring between the individual fishery inspectors indicating high convergence. The positive opinion on at-sea control might however be somewhat influenced by the respondents, since several responding fishery inspectors perform at-sea control in their daily work and thereby might be inclined to favour this measure. Despite this, REM was ranked as the third best option out of seven possible, had the same median ranking as at-sea control and scored a top ranking among several of the respondents. The overall opinion on REM among fishery inspectors is thus quite divergent. One in six fishery inspectors stated they are against the use of REM and two almost equally large groups were either "for" or "neither for nor against" the use of video documentation. It may be kept in mind that the large group of fishery inspectors who stated "neither for nor against" to the question on their general opinion towards REM, may be influenced in their response by their position as government officials. Because the final decision on the use of REM is political, some responders may find it inappropriate to take position for or against this MCS measure. This could also explain why six fishery inspectors had nothing positive to say about REM whereas five stated they were against the measure. The political opinion has previously been in favour of REM in Denmark [38,39], however the current administration has not been clear in its support of REM.

Interviewed fishers in favour of REM added that a reward should accompany the REM system, and pointed to quota uplifts as the preferred option. The fact that Danish trials on REM has been voluntary and have been conducted mainly with a quota premium as the reward may have influenced the views of REM-experienced fishers. The responses are however in line with the report by Hedley et al. (2015) that stated that due to the voluntary nature of the trials using REM it is difficult to infer how REM would work if it would become compulsory for all vessels, with no quota premium given as compensation [8]. While none of the non-REM-experienced fishers were supportive of the use of REM, it is worth noting that the majority of REM-experienced fishers were supportive of it. Based on this study it cannot be inferred whether these fishers were positive towards REM as a MCS measure before they started in a REM trial. However, it can be said that participation in a REM trial has not led to a general antipathy towards the measure.

4.2. Opinions on the landing obligation

The majority of responding fishery inspectors stated that the largest challenge for the fishery control with the landing obligation will be to actually enforce the regulation. Current Danish fishery control uses at-sea control, landings control and self-reported catches in the electronic logbook to perform a risk-based management [40,41]. With the majority of fishery inspectors fearing that the landing obligation cannot be enforced properly, it seems that these methods are believed to be insufficient as tools to verify total catches and not just landings. Though the majority of responding fishery inspectors believed the landing obligation will have a positive effect on the marine environment, a large group of respondents were nevertheless doubtful as to what will happen. Concerns were raised on the impact of removing the "free" food source that discards act as. Fishery inspectors were less certain as to whether this effect will be negative for the ecosystem than the responding fishers were. The true ecological effect of removing discards is unclear. Some studies have pointed to the reduced food availability as a potential negative effect of reduced discards, especially for seabird populations and primary scavengers [42–44], although the actual effects up the food chain and in the long-term effects are uncertain but likely limited [4,45]. The effect of reducing the food source from discards depend on several factors and the potential increase in selectivity and reduced fishing mortality are likely to mean a net positive effect on fish stocks [42,43].

Regarding the effect on fisheries, a third of fishery inspectors expressed confidence in the adaptability of the industry and the effect of a better public image, but another third of them believed the landing obligation will have a negative effect on the Danish fisheries, mainly due to increased complexity and mismatch in regulations.

The notable resentment towards the landing obligation among responding fishers together with the fishery inspectors' disbelief in a viable control and enforcement of the regulation raise concerns. Compliance behaviour among fishers has been found to be influenced by whether regulations are seen as meaningful and legitimate [46–48]. In an earlier Danish study, it was found that if fishers begin to violate regulations, it can create a shift in the attitude towards a regulation, were non-compliance may become the norm rather than the exception [47]. Interestingly, that study reported fishers to find it morally wrong to discard catches that are dead [47], whereas this ethical aspect did not appear strongly in the present interviews.

No difference in the attitude towards the landing obligation based on gear, target species or fishing area was presented in this study because no such difference was found. One might have expected to see a lower resentment towards the landing obligation among fisheries with a high selectivity, like gillnetters. However, that this is not seen in this study may both be due to the low number of responding fishers using gillnet and the general uncertainty among fishers as to how the landing obligation will be when it is fully implemented.

4.3. REM and the landing obligation

Based on the responses regarding the landing obligation there seems to be a need for MCS measures if compliance is to be ensured. Article 15 in the 2013 CFP state that:

> "*For the purpose of monitoring compliance with the landing obligation, Member States shall ensure detailed and accurate documentation of all fishing trips and adequate capacity and means, such as observers, closed-circuit television (CCTV) and others. In doing so, Member States shall respect the principle of efficiency and proportionality*." [13].

Looking at the more technical criticism raised by responders in the present study, the shortcomings portrayed for REM focused on the cost of running a REM system, malfunctions and that the system does not truly ensure full documentation. All of these points are valid, but should be kept in comparison with the alternative MCS measures. The workload and thereby cost of auditing video footage can be reduced by doing samples, as has been the case in the Danish Cod Catch Quota Management trial [14,49]. Hereby a certain percentage of the total video footage is reviewed. This percentage can be lowered or increased depending on factors like available funds and the level of control deemed adequate. If non-compliance or suspicious behaviour occur in the sampled footage, the amount of reviewed data can be increased to comprehensively document potential non-compliance. Fitting REM onto vessels and recording all fishing activities does not automatically mean reviewing all the video footage. It is therefore more accurate to compare the level of control with those obtained with current control measures, like at-sea control and on-board observers. With such a comparison both the cost and the workload involved in reviewing video footage seems less cumbersome and is likely to be cheaper [15,16,23,50]. Additionally, because of the random selection procedures often used in REM trials, the fishers do not know which footage will be selected for review. This mean that although only a certain percentage of the video footage is reviewed, essentially REM allow for 100% monitoring coverage of fishing activities which would be very costly to obtain with on-board observers [14,16,23].

Finally, the technology is in constant development, and there are great potentials for achieving full review of all video footage in the future using automated image analysis [23,32]. The technology is nowadays still vulnerable to dirt on camera lenses, distortions in the field of video view and periods where large quantities of fish occur on the discard belt [32]. However, further development may enable video audit to be done mainly by computer software, supported by trained personnel in order to determine the course of action when the computer software is unable to distinguish or if malfunctions occur.

The possibility to bypass REM and practice non-compliance cannot be dismissed. However, this is also true for other MCS measures like at-sea control or landings control, because these measures only allow for limited or no presence during the handling of catches at sea. For a given haul, using on-board observers is likely to ensure better data and a higher degree of full documentation than REM, because observers can perform additional measurements, which are not possible with a video system, and observers are less likely to be affected by blind spots during catch processing [16]. Discrepancies between observers, fishers estimates and REM data may still occur, especially when the quantities observed are small [14,24]. The reasons for these discrepancies must be carefully investigated and the estimation protocols adapted if necessary. Nevertheless, it must be noted that in many cases, these discrepancies lead to uncertain but not necessarily biased estimates [14,24]. While it might always be possible to bypass a REM system, it may also be relevant to speculate whether and when it is profitable for a fisher to bypass the system? If the perceived effort to bypass the MCS measure is greater than the perceived gain from non-compliance, it would make more sense simply to comply with the regulation. In the Danish Cod Catch Quota Management trials, self-sampling estimates were often higher than estimates from video audit, even though the reported discards were deduced from the quota [14,51] This could indicate that compliance was generally perceived as more beneficial than non-compliance. If so, self-sampling verified by REM has fulfilled its purpose, regardless of whether the REM system can be bypassed or not.

Possibly the largest reservation against the use of REM is the ethical dilemma it presents. The strong resentment towards the surveillance level is the main weakness of REM [3,16]. Rather than making REM compulsory it may be easier to establish a voluntary reference fleet where self-reported catches are verified by REM. As in the Norwegian reference fleet, the benefit for vessels could be quota uplifts [16]. Alternatively, it has been suggested to use a *quid-pro-quo* approach where fishers who agree to have a high level of MCS that allow for accurate catch data are rewarded with higher quotas than fishers who chose to be under less extensive MCS [52]. The logic behind is that it

should count in one's favour to provide accurate catch data whereas those not willing to provide accurate catch data are assumed to continue with a certain level of discarding which is then reflected in their quota. The actual use and ownership of video footage may also improve fishers' opinion on REM. Using the practice for trucks' black boxes as a model, clear division and rules underlining that fishers has the ownership of REM data would minimise the risk of third parties getting hold of video footage and use it to discredit the fishing industry, an issue which fishers pointed to both in this survey and in a UK study [16]. For MCS purposes, the fisheries control authorities could ask for video documentation by the fisher in question in cases where non-compliance were suspected, thus reversing the burden of proof and bringing the responsibility back to the fishers.

If REM is ruled out as a MCS measure, it will be necessary to ensure compliance by some other mean. Creating economic incentives that make rule compliance more favourable than non-compliance might be possible, e.g. by utilization of fish below the Minimum Conservation Reference Size [42]. However, this approach is a delicate balance, because the possible profit gained from utilization has to be at level where it does not counteract the incentive for good gear selectivity [4,42,44]. The use of on-board observers has the potential to ensure compliance with the landing obligation, but the extent of such a MCS measure is likely to be very costly. Additionally, making on-board observers mandatory may also be seen as an intrusion just like the use of REM. In the North Pacific, McElderry reported REM monitored fishers to prefer REM over on-board observers as the presence of cameras were seen as less intrusive [53].

5. Conclusion

The responses from interviews and questionnaires point to great uncertainties regarding the perceived effects of the landing obligation and whether the landing obligation will be complied with. Not only does it appear that the regulation is often not perceived as meaningful in the Danish fishery community, it is also largely seen as impossible to enforce by the fishery inspectors. This mistrust will clearly be a major hindrance to the full implementation of the landing obligation. The use of REM is considered as a mean to ensure compliance and to document whether fishers exploit the marine resources in a sustainable manner. However, the mandatory use of REM is likely to be met with opposition from the fishing community. On the other hand, it is worth noting that the majority of fishers who had participated in a REM trial did not display strong antipathy against REM. In addition, the majority of fishery inspectors believe that the landing obligation cannot be enforced properly, meaning that the current methods of at-sea and at-port control are perceived as inadequate for the control of total catches. The mandatory use of on-board observers will likely be very costly, and may neither be considered positively by the fishing community. In parallel with extending and enhancing MCS measures, it is therefore crucial to design incentives for compliance [9]. There are many different approaches and combinations of MCS measures, which could come into play as means to verify compliance with the landing obligation [8,11,33], and different options might be suitable in different fisheries. In the frame of the increased regionalisation framed by the 2013 CFP, increased dialogue between managers, fishers, controllers and scientists is taking place within each Member State, hopefully paving a way for future fisheries management that is both legitimate and effective.

Acknowledgements

This work is the result of scientific and policy developments channeled over multiple forums for the different authors. This includes funding from the Horizon 2020 Programme under grant agreement DiscardLess number 633680. This support is gratefully acknowledged. The authors thankfully acknowledge the support from fishers and fishery inspectors who have participated in interviews or responded to questionnaires. Additionally, Lotte Kindt-Larsen and Jesper Bech Eiersted deserves a special thank for their support in the development of questionnaires and distribution among fishery inspectors.

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